# Evaluation of the Tracy Fish Collection Facility Holding Tank Screen Entrainment Efficiency for Juvenile Delta Smelt

## Investigators

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## Summary

The U.S. Bureau of Reclamation (Reclamation), Tracy Fish Collection Facility (TFCF) is located at the head of the Delta-Mendota Canal (DMC) 4 km northeast of the C.W. "Bill" Jones Pumping Plant (JPP; formerly Tracy Pumping Plant) and 14.5 km northwest of Tracy, California (San Joaquin County). Reclamation's JPP exports up to 130.26 cubic meters per second (cms) of water south for agricultural, municipal, and industrial use out of the Sacramento-San Joaquin Delta (SSJD; Arthur *et al.* 1996). The TFCF was built in 1956 by Reclamation to remove Chinook salmon (*Oncorhynchus tshawytscha*) and striped bass (*Morone saxatilis*) ≥20mm FL from the DMC. Once fish are removed from the DMC, they are held in 6.1-m-diameter concrete holding tanks for 8–12 h or until transportation back to the Delta is deemed necessary according to the Bates truck loading tables. The number of fish in the holding tanks and haul-out trucks are estimated using the fish count procedure in which a sub-sample of the water flowing into the tanks is taken every 2 h.

In 2004 and 2005 the fish count procedure was tested for its efficiency in retaining juvenile delta smelt (*Hypomesus transpacificus*). These data were released in 2007 and show that a large percentage of delta smelt 20–30 mm FL are passing through the screen used at the fish count station (Sutphin *et al.* 2007) and are not able to be counted. Consequently, the number of fish entering and accumulating in the holding tank between sub-samples may be larger than our estimated amount which can result in overloading and affect the water quality in the fish-haul truck. From the 2007 study, it was determined that a fish count screen hole size of ≤2.5 mm in diameter is needed to guarantee a 20-mm FL delta smelt is not lost through the screen holes (Sutphin *et al.* 2007). The current holding tank screen maximum diameter is 4.3 mm (Sutphin *et al.* 2007); therefore loss from the holding tank screens is expected and may be as large as that found at the fish count station screen. The loss of entrained fish through the holding tank screen potentially results in pump mortality and does not allow for the accurate

estimation of the fish loading densities in the fish-haul truck by extrapolation of fish count data. Determining which size classes of delta smelt are effectively retained in the holding tank will help us to verify the effectiveness of the current holding tank screen at retaining ≥20 mm delta smelt as well as gain insight on the accuracy of TFCF juvenile smelt salvage data along with the accuracy of the fish loading densities in the fish haul truck.

Preliminary data collected in FY 2010 aimed to verify that the 500-µm net was effective at retaining larval and juvenile delta smelt, improve efficiency of the net and sample collection procedure, and quantify the holding tank screen entrainment efficiency for five size classes (10–14.9, 15–19.9, 20–24.9, 25–29.9, and 30–34.9 mm SL) of larval and juvenile delta smelt during 0, 1, 5, 15 and 30-minute (min) swirl periods. This was done with net verification replicates, vet and sample collection improvement replicates, and holding tank screen efficiency experiments, respectively.

Results of our FY 2010 data suggest that our 500-µm net did retain most larval and juvenile delta smelt and the fish could be recovered from the net by thoroughly rinsing. Installing a seal on the lip of the sample net frame and using a high pressure hose for all rinsing activity drastically increased the percentage of injected larval and juvenile delta smelt that were recovered in our net.

During holding tank screen entrainment efficiency experiments, on average, 27% of the 10- to 14.9-mm SL delta smelt and 22% of the 15- to 19.9-mm SL delta smelt were successfully recovered in the net during the 0-min swirl replicates. On average, 20% of the 10- to 14.9-mm SL and 15- to 19.9-mm SL size classes were recovered during the 1-min swirl replicates. Fifteen percent, on average, of the 10- to 14.9-mm SL size class and 13%, on average, of the 15- to 19.9-mm SL size class were recovered in the 5-min swirl replicates, whereas 0% and 6% recovery was observed for the 10- to 14.9 and 15- to 19.9-mm SL size classes, respectively, during the 30-min swirl replicates. Holding tank screen efficiency replicates for the15-min swirl periods have been completed and the samples have been collected. Despite this, the samples have yet to be processed or analyzed and data for the average percent recovery of juvenile delta smelt, during the 15-min swirl period, is not currently available.

All equipment for this study was purchased in 2007 (500-µm net, net frame) although work was not possible due to construction activity at the TFCF. Modifications (collar was added in order to fit net to frame) to the net were made in March 2008. Two new 500-µm nets were ordered and received before the FY 2009 study period and will be used for continuing 2010 and 2011 research activity.

## Problem Statement

The loss of delta smelt between 20 and 30 mm through the holding tank screen results in pump mortality as well as inaccurate estimation of the both the number of fish salvaged and the fish loading densities in the fish haul truck. The primary objective of this study is to determine the holding tank screen entrainment efficiency for five size classes (10–14.9, 15–19.9, 20–24.9, 25–29.9, and 30–34.9 mm SL) of larval and juvenile delta smelt during 0-, 1-, 5-, 15- and 30-min swirl periods. Determining which size classes of delta smelt are effectively retained in the holding tank will help us to verify the effectiveness of the current holding tank screen at retaining ≥20-mm delta smelt as well

as gain insight on the accuracy of TFCF juvenile smelt salvage data along with the accuracy of the fish loading densities in the fish haul truck.

## Goals and Hypotheses

*Goals:*

1. Determine the holding tank screen entrainment efficiency for five size classes (10–14.9, 15–19.9, 20–24.9, 25–29.9 and 30–34.9 mm TL) of larval and juvenile delta smelt during 0-, 1-, 5-, 15- and 30-min swirl periods.

2. Develop a probability-capture curve for larval and juvenile delta smelt based on standard length (10–14.9, 15–19.9, 20–24.9, 25–29.9 and 30–34.9 mm) and the amount of time swirled in the holding tanks (0, 1, 5, 15 and 30 min).

*Hypotheses:*

1. The holding tank screen entrainment efficiency will increase with increasing size of larval and juvenile delta smelt for 0-, 1-, 5-, 15- and 30-min swirl periods.

2. The holding tank screen entrainment efficiency for all size classes will be reduced with increased swirl time.

## Materials and Methods

*Holding Tank Screen Efficiency Experiment*

During the holding tank screen efficiency trials completed in 2008, all measurements of delta smelt were taken at the TFCF after the fish were picked up from the FCCL and transported to the TFCF in 18.9-L black buckets with lids. In 2008, only 50 delta smelt from each of the groups of fish picked up from the FCCL were measured in order to determine the size distribution of the fish in each group. Standard length, fork length, total length and maximum body depth measurements were obtained for the 50 fish out of each group using a 50 mg/L MS-222 solution and a Leica™ $MZ7_5$ stereomicroscope (Leica Microsystems, Bannockburn, Illinois) equipped with a micrometer. These size distributions were then applied to the remaining unmeasured fish in each group in order to estimate the number of each sized fish in each of the different groups. This process allowed us to acquire accurate measurements of the delta smelt, as well as determine the size distribution of each group, without compromising the condition of the fish used in the holding tank screen efficiency experiment. The net and frame were not inserted into the drainage pit during the collection/swirl periods during the 2008 holding tank screen efficiency trials and only the fish that were effectively withheld in the holding tank were available for post-trial collection and measurement. Two 0-min swirl replicates, one 1-min swirl replicate, two 5-min swirl replicates, one 15-min swirl replicate and one 30-min swirl replicate were completed in this manner.

During the holding tank screen efficiency replicates completed during 2009, all 100 delta smelt that were injected for each replicate were measured. Standard length, fork length, total length and maximum body depth measurements were obtained for the 100 fish that were injected using a 50 mg/L MS-222 solution and a Leica $MZ7_5$ stereomicroscope equipped with a micrometer. This was done in order to determine the

exact size distribution of each injection group and prevent problems in data analysis. The net and frame were not inserted into the drainage pit during the collection/swirl periods during the 2008 holding tank screen efficiency trials and only the fish that were effectively withheld in the holding tank were available for post-trial collection and measurement. One 1-min swirl replicate, one 15-min swirl replicate and two 30-min swirl replicates were completed in this manner.

In 2010 and 2011, the net and frame will be inserted into the drainage pit for the entire collection/swirl period in order to catch all fish that passed through the holding tank screen and would otherwise be lost. In this case, both fish that were not successfully withheld in the holding tank as well as those that were effectively withheld are available to be collected and measured. This makes it possible for us to inject unmeasured delta smelt into the holding tank and measure them upon collection in our net for size comparison between groups. In order to develop a probability-capture curve for fish size and swirl time, determine the holding tank screen entrainment efficiency during the routine 30-min fish counts performed at the TFCF during delta smelt season, and verify if the current holding tank screen size is sufficient in retaining ≥20-mm delta smelt during 30-min fish counts, 0, 1, 5, 15 and 30 min samples will be made in TFCF holding tanks during a period of time when there is adequate water temperature (14.6°C–17.5°C) and no wild delta smelt present, for take purposes. Delta smelt from the FCCL will be held in ambient Delta water prior to insertion. The net and frame will be placed in the drainage pit using the same hoist intended for the fish count and haul-out buckets and the holding tank will be filled using the "collect" valve. A known number of unmeasured cultured delta smelt will be inserted into the holding tank using a water-to-water method in which the 18.9-L black buckets will be lowered with a rope and poured. Holding tank valves will be put into operation to initiate collection and water flow through the holding tank screen. During the specified collection period, flow will be regulated using holding tank pumps (one or two) to mimic typical flowrates when wild delta smelt are salvaged. Flow rates (cms), tank water depths (m), and temperature (°C) will be recorded. After the collection period, the holding tank will be drained to an approximate depth 0.61 m. The net and frame will be lifted out of the drainage pit and sample 1 (fish that were not effectively withheld in the holding tank) will be collected by rinsing the net into 18.9-L buckets. The net and frame will be reinserted into the holding tank and the "collect" valve will be used to fill the holding tank until water levels inside and outside of the holding tank screen are equal. This process eliminates the problem of a sudden force of water lifting our net frame and the possible loss of fish. Once equilibrium has been achieved, the holding tank screen will be lifted up and sample 2 (fish that were effectively withheld in the holding tank) will be collected in our net. The holding tank will then be rinsed using a high pressure hose and our net will be removed and rinsed into 18.9-L buckets. The samples will then be separately consolidated into one fine meshed (0.39-mm) dipnet by pouring the contents of each 18.9-L bucket into the dipnet. The samples will then be bathed for 5 minutes in Rose Bengal for staining. After this, the samples will be thoroughly rinsed and placed into a pyrex dish on a light table. All delta smelt will be picked out of the samples. Standard length, fork length, total length and maximum depth (from the insertion of the first dorsal ray to the insertion of the first anal ray) will be recorded for all delta smelt collected. By catch of fish ≥20 mm will be

identified to species and measured (FL). We need approximately 500 fish released at each size/time combination to estimate efficiency within 5% with a power of 0.8.

*Data Analyses*

We intend to perform up to five replicates for each size class and swirl time. Analysis of covariance will be used to determine if fish size and length of swirl significantly change the probability of capture. A probability-capture curve, with 95% confidence intervals, will then be developed using the Logit link function for fish size and swirl time. This probability-capture curve will allow us to determine the holding tank screen entrainment efficiency, for the six size classes of juvenile delta smelt, during 0-, 1-, 5-, 15- and 30-min swirl periods. Linear regression will be used to determine the relationship between waterflow rates in the holding tank and fish loss. Data analysis will be completed by August 2011.

## Coordination and Collaboration

All experiments will be coordinated with the TFCF Fish Diversion Operators (Joel Imai) along with the TFCF Biology staff (Brent Bridges). During data collection it will be necessary to utilize a TFCF holding tank and the bucket hoist. Participation and inclusion of research-related updates will be provided at regularly scheduled Tracy Technical Advisory Team (TTAT) and/or Central Valley Fish Facilities Review Team (CVFFRT) meetings.

## Endangered Species Concerns

We will be using larval and juvenile stages of domestically reared delta smelt and have timed the tests so that they do not coincide with periods when wild ESA listed delta smelt are present. However, incidental "take" of ESA listed Chinook salmon and/or steelhead trout (*O. mykiss*) is likely to occur during the tests. If collected, ESA listed Chinook salmon and steelhead trout will be measured and released alive back into the normal salvage operations. All larval and/or juvenile delta smelt that are encountered during testing will not be released alive back into the Delta.

## Dissemination of Results (Deliverables and Outcomes)

A Tracy Series Report volume will be prepared and published upon completion of the study. Updates and presentations of progress will be provided internally and upon request by TTAT and other interagency technical forums. A draft report is tentatively scheduled to be completed by September 2011 and a final draft report will be finished by December 2011.

## Literature Cited

Arthur, J.F., M.D. Ball, and S.Y. Baughman. 1996. *Summary of federal and state water project environmental impacts in the San Francisco Bay-Delta Estuary, California*. Pages 445-495 *in* J.T. Hollibaugh, editor. San Francisco Bay: The Ecosystem, Further Investigations into the Natural History of San Francisco Bay and Delta With Reference to the Influence of Man. Pacific Division of the American Association for the Advancement of Science, California Academy of Sciences, San Francisco, California

Sutphin, Z., B. Bridges, B. Baskerville-Bridges, and R. Reyes. 2007. *Evaluation of current and historical 10-minute-count screens at the Tracy Fish Collection Facility, Tracy, California*. Tracy Fish Collection Facility Studies, Volume 31. U.S. Bureau of Reclamation, Mid-Pacific Region and Technical Service Center and University of California, Davis.